CHES STUDIES

A Special Report Series by
THE STATE CENTER FOR HEALTH AND ENVIRONMENTAL STATISTICS
P.O. Box 29538, Raleigh, N.C. 27626-0538

No. 81 March 1994

MATERNAL OBESITY AND EXCESS RISK OF PERINATAL MORTALITY: EVIDENCE FROM A LARGE BIRACIAL POPULATION

by

Elizabeth Barnett
David A. Savitz
Irva Hertz-Picciotto

ABSTRACT

To investigate the risk of perinatal death associated with maternal obesity, a cohort of low-income women who participated in the North Carolina WIC program during 1988-90 was evaluated retrospectively. Blacks (N=45,651) and Whites (N=40,929) were considered separately. Perinatal mortality rate ratios for moderate overweight and obesity were calculated using normal weight women as the referent group. A logistic regression analysis provided adjusted estimates of the relative risks of perinatal mortality associated with maternal overweight and obesity.

Maternal obesity was associated with an excess risk of perinatal death among both Blacks (RR=1.3) and Whites (RR=1.5), after adjustment for maternal age, education, parity, cigarette smoking, gestational weight gain, diabetes and hypertension. There was no overall elevated risk of perinatal death among infants of moderately overweight women for either Blacks or Whites. For both race groups, stronger associations of maternal obesity with perinatal mortality were observed among women less than 18 years old, women 35 years or older, and women with adequate or excessive gestational weight gain.

The results of this study confirm that obesity is a major risk factor for perinatal mortality, not solely due to risk factors associated with obesity, such as diabetes and hypertension. The high prevalence of obesity among low-income women, which leads to high rates of chronic disease in later life, adversely affects reproductive outcomes as well.

INTRODUCTION

Maternal obesity confers some advantages on the developing fetus. Infants of obese mothers are less likely to be born prematurely or have low birth weight, and obese women are also less likely to suffer from iron-deficiency anemia during pregnancy[1-6]. However, there has been a general consensus among clinicians and researchers that obese women are more likely to suffer pregnancy complications than normal weight women[1-13]. Early studies of obesity and pregnancy reported increased risks of pre-eclampsia, diabetes, cesarean delivery, and maternal mortality[11-13]. More recent studies have found higher risks of hypertensive disorders, urinary tract infections, postpartum wound infections, and multiple gestations among obese pregnant women[1-6].

In addition, there is evidence from several epidemiologic studies that infants of obese women suffer higher rates of perinatal mortality than infants of normal weight women[1-3,6,9,10,14,15]. However, only two of these studies explicitly considered the high risk conditions (e.g. diabetes and hypertension) that often accompany maternal obesity in assessing the risk of perinatal mortality[1,3] and only one study presented race-specific analyses[10]. The main objective of the present study was to investigate the risk of perinatal death among infants of obese Black and White women with consideration of maternal age, education, parity, cigarette smoking, gestational weight gain, diabetes, and hypertension.

The large number of pregnant women for whom data were available (N=95,328) was an important strength of this study, which included over 9,000 obese women. Previous studies of maternal obesity and perinatal mortality have been limited by small numbers of obese women. The only cohort of comparable size is the Collaborative Perinatal Project, in which deliveries occurred over thirty years ago[1,14]. Since the early 1960's, rates of perinatal mortality have declined significantly and obstetric management of pregnancies complicated by obesity has also changed.

We also examined the relationship of obesity to perinatal mortality separately for Black and White women. To our knowledge, only one previous report has assessed the perinatal risks of obesity among Black women[10], even though Blacks suffer much greater rates of both obesity and perinatal mortality than White[16,17].

MATERIALS AND METHODS

This study examined data from a cohort of low-income women who participated in the North Carolina Special Supplemental Food Program for Women, Infants and Children (WIC) during pregnancy, and whose pregnancies ended in either a live birth or fetal death during 1988, 1989 or 1990. Data on 95,328 women were available for this study. There were too few fetal and infant deaths among American Indians, Asian Americans, and Hispanics during the three-year study period to analyze these groups. Because infants of underweight women have been shown to be at increased risk of perinatal mortality[3], and because the causes of perinatal mortality for infants born to obese mothers may differ from the causes for infants of underweight mothers, this study included women of normal or greater prepregnancy body mass index only.

Descriptive analyses were conducted on 86,580 pregnancies after the following hierarchical exclusions were made—2,046 multiple births and 6,702 Native American, Asian and Hispanic women. After further exclusion of 20,258 women who were underweight prior to pregnancy, the final analysis dataset contained pregnancy risk factor and outcome data for 66,322 pregnancies.

There were two principle data sources for this study—WIC Program certification records and vital records. Weight, height, and smoking data for pregnant women were extracted from WIC prenatal and postpartum certification records and linked to pregnancy risk factor and outcome data from birth certificates, fetal death reports, and infant death certificates. Only women whose prenatal WIC records matched a fetal death report or infant birth certificate were included in

the study population. Details of the dataset matching procedures used are available from the authors on request.

Prepregnancy body mass index (BMI) was calculated using weight and height data from the WIC prenatal record. Prepregnancy weight was self-reported to a nutritionist at the first WIC prenatal visit. Three categories of prepregnancy BMI were analyzed in this study—normal weight, moderately overweight, and obese (Table 1). The cutpoints for normal weight, moderate overweight and obesity correspond to 90% - 120%, 120%-150%, and greater than 150% of the Metropolitan Life Insurance ideal weights for women[18]. For this study, all fetal deaths of 20 weeks gestation or greater and all deaths of liveborn infants less than 28 days old were considered perinatal deaths.

Table 1
Definition of the Study Groups

	BMI* Cutpoints	Median Weight in Pounds	Number
Blacks			
Normal weight	19.8-26.0	132	21,939
Overweight	26.1-32.0	167	9,220
Obese	> 32.0	215	5,478
Whites			
Normal weight	19.8-26.0	130	19,068
Overweight	26.1-32.0	167	6,752
Obese	> 32.0	212	3,865

*BMI = Body Mass Index (metric), calculated as (lbs./inches^2 *700). Based on self-reported prepregnancy weight.

Maternal age at the time of delivery, maternal education and maternal parity were obtained from the birth certificate or fetal death report. Cigarette smoking during pregnancy was recorded on both the WIC prenatal record and the North Carolina birth certificate or fetal death report. A woman was considered a smoker if she was coded as a smoker on either record.

Prepregnancy weight taken from the WIC prenatal record was subtracted from end-of-pregnancy in the WIC postpartum record to obtain a measure of total gestational weight gain. Gestational weight gain could not be calculated for those records that were missing end-of-pregnancy weight (23% of all records). For those records, total gestational weight gain recorded on the birth certificate or fetal death report was used. For each pregnancy, length of gestation and prepregnancy BMI category (normal weight, moderately overweight, or obese) were used to calculate whether total weight gain was inadequate, adequate, or excessive, based on national weight gain recommendations[19].

For normal weight women, the recommended gain is 25 to 35 pounds at term; therefore less than 25 pounds was considered inadequate and greater than 35 pounds was considered excessive in this study. Overweight women are advised to gain 15 to 25 pounds, while obese women are advised to gain at least 15 pounds. Since there is no recommended upper limit of weight gain for obese women, we used an upper limit of 25 pounds for both moderately overweight and obese women who delivered at term.

In order to estimate adequacy of weight gain for women who delivered preterm, tables of cumulative minimum and maximum recommended weight gain for each week of gestation after the first trimester were constructed for each BMI group. Weight gains that were less than, greater than, or within the recommended range for gestational duration were considered inadequate, excessive, and adequate, respectively.

Diagnoses of maternal diabetes and hypertension were extracted from the medical risk factor section of the birth certificate or fetal death report. Lack of a

recorded diagnosis of either condition on the vital record was considered absence of the condition. Diabetes included both chronic and gestational diabetes. Similarly, hypertension included both chronic and pregnancy-associated hypertension.

All analyses were conducted separately for Blacks and Whites. Perinatal mortality rates were calculated for infants of normal weight, moderately overweight and obese women. Rate ratios and rate differences for the moderately overweight and obese groups were calculated using normal weight women as the referent group. Relative risks of perinatal mortality for moderate overweight and obesity, adjusted for maternal age, education, parity, cigarette smoking, gestational weight gain, diabetes, and hypertension, were estimated using a logistic regression analysis.

The strength of the association between maternal overweight and obesity and perinatal mortality stratified by several perinatal risk factors was also evaluated. Separate logistic regression models were run for women in each risk factor category. Estimated relative risks (adjusted odds ratios) of perinatal mortality for moderate overweight and obesity, and 95% confidence intervals were calculated from the regression coefficients and standard errors.

RESULTS

The initial study population, including underweight women, consisted of 45,651 Blacks and 40,929 Whites. The distributions of demographic, nutritional and medical characteristics for these two study groups are provided in Table 2. Underweight women were subsequently excluded from further analyses.

Over 30% of Blacks and over 25% of Whites within the study population were moderately overweight or obese. The prevalence of obesity was slightly higher among Blacks (12.0%) than among Whites (9.4%) (Table 2). Blacks tended to have more education, to be of higher parity, were less likely to be smokers, and had lower gestational weight gains.

Table 2
Demographic and Reproductive Characteristics of the Study Population

	Blacks (N=45,651)	Whites (N=40,929)
Prepregnancy Body Mass Index		
underweight	19.7%	27.5%
normal weight	48.1%	46.6%
overweight	20.2%	16.5%
obese	12.0%	9.4%
Age		
<18	14.7%	11.7%
18-25	59.1%	64.7%
26-34	23.3%	21.3%
35+	2.9%	2.3%
Education		
<9 years	4.2%	8.1%
9-11 years	32.7%	41.2%
12 years	48.8%	41.1%
>12 years	14.3%	9.5%
Parity		
0	43.3%	46.1%
1-2	46.1%	46.9%
3+	10.6%	7.0%
Gestational Weight Gain		
inadequate	34.4%	26.9%
adequate	29.8%	31.8%
excessive	35.8%	41.4%
Cigarettes Smoked Per Day		
0	78.8%	53.3%
1-10	17.7%	28.3%
11+	3.5%	18.4%
Diabetes		
absent	97.6%	96.9%
present	2.4%	3.1%
Hypertension		
absent	95.4%	95.5%
present	4.6%	4.5%

The prevalence of obesity varied markedly in relation to demographic, nutritional and medical characteristics of both the Black and White study populations (Table 3). Among both race groups, the prevalence of obesity increased dramatically with advancing age, rising over six-fold from youngest to oldest women. Higher education and higher parity were both associated with a higher prevalence of obesity among Blacks and Whites in this low-income population. The prevalence of obesity did not vary greatly by either adequacy of gestational weight gain or cigarette smoking.

Diabetes and hypertension showed the most dramatic associations with prevalence of obesity. Among women without diabetes, the prevalence of obesity was 11.4% for Blacks and 8.9% for Whites. Among women with diabetes, the prevalence of obesity was approximately three times as high (37.9% among Blacks and 25.9% among Whites). Similarly, the prevalence of obesity was approximately three times greater among both Black and White hypertensives compared with non-hypertensives.

Perinatal mortality rates for infants of normal weight, moderately overweight and obese women are shown in Table 4. There was no elevated risk of perinatal death among infants of moderately overweight women for either Blacks or Whites. However, there was an excess risk of perinatal mortality among infants of obese women for both Blacks (RR=1.4) and Whites (RR=1.6), corresponding to 5.4 and 6.7 excess deaths per 1000, respectively. Adjustment for age, education, parity, cigarette smoking, gestational weight gain, diabetes and hypertension did not notably alter the relative risks for moderate overweight and obesity among either Blacks or Whites (Table 4).

Among Blacks (Table 5), stratum-specific relative risks of perinatal mortality for obesity exceeded the overall relative risk for women less than 18 years old,

Table 3
Prevalence of Obesity by Selected Risk Factors for Perinatal Mortality

	Blacks	Whites
Age		
<18	3.8%	2.5%
18-25	10.8%	8.6%
26-34	18.4%	15.1%
35+	26.3%	16.5%
Education		
<9 years	8.4%	7.6%
9-11 years	9.8%	7.5%
12 years	12.8%	10.8%
>12 years	15.3%	13.7%
Parity		
0	9.1%	7.0%
1-2	13.6%	11.2%
3+	16.9%	13.8%
Gestational Weight Gain		
inadequate	11.9%	10.7%
adequate	10.1%	7.6%
excessive	13.6%	10.1%
Cigarettes Smoked Per Day		
0	12.1%	11.3%
1-10	11.6%	7.0%
11+	12.0%	8.2%
Diabetes		
absent	11.4%	8.9%
present	37.9%	25.9%
Hypertension		
absent	11.2%	8.7%
present	30.0%	25.3%

Table 4
Perinatal Mortality Rates by Maternal Prepregnancy BMI

Study Group	Number of Perinatal Deaths	Perinatal Mortality Rate	Rate Ratio (95% CI)	Adjusted * Relative Risk (95% CI)
Blacks				
Normal Weight	302	13.8/1000	1.0	1.0
Overweight	136	14.8/1000	1.1 (0.9-1.3)	1.1 (0.9-1.4)
Obese	105	19.2/1000	1.4 (1.1-1.7)	1.3 (1.0-1.6)
Whites				
Normal Weight	199	10.4/1000	1.0	1.0
Overweight	71	10.5/1000	1.0 (0.8-1.3)	1.1 (0.8-1.4)
Obese	66	17.1/1000	1.6 (1.2-2.2)	1.5 (1.1-2.1)

*Logistic regression estimates of the relative risk, after adjustment for age (<18, 18-34, 35+), education (<12 years, 12+ years), parity (0, 1-2, 3+), smoking (yes, no), gestational weight gain (inadequate, adequate, excessive), diabetes (yes, no) and hypertension (yes, no).

Table 5
Adjusted Logistic Regression Estimates of the Relative Risk of Perinatal Mortality for Overweight and Obesity Among Blacks

Risk Group		Overweight	Obese	Number
Age	<18[1]	1.5 (0.8-2.8)	1.6 (0.6-4.3)	4,670
	18-34	1.1 (0.8-1.4)	1.2 (0.9-1.6)	28,856
	35+	0.5 (0.2-1.8)	1.4 (0.5-4.0)	1,146
Education	<12 years	1.1 (0.7-1.6)	1.2 (0.8-2.1)	12,218
	12+ years	1.1 (0.8-1.4)	1.3 (0.9-1.7)	22,454
Parity	0	1.5 (1.1-2.1)	1.9 (1.3-2.7)	14,561
	1-2	0.9 (0.6-1.2)	0.8 (0.5-1.2)	16,382
	3+[2]	0.6 (0.3-1.3)	1.3 (0.7-2.8)	3,729
Cigarettes Smoked/Day	0	1.1 (0.8-1.3)	1.2 (0.9-1.6)	27,482
	1+	1.1 (0.7-1.7)	1.5 (0.9-2.4)	7,190
Gestational Weight Gain	inadequate	1.0 (0.7-1.3)	0.8 (0.6-1.2)	13,855
	adequate	0.9 (0.5-1.5)	1.8 (1.0-3.1)	10,054
	excessive	1.4 (0.9-2.1)	2.4 (1.5-3.8)	10,763
Diabetes	absent	1.1 (0.9-1.4)	1.3 (1.0-1.7)	33,743
	present	0.9 (0.2-3.6)	1.2 (0.3-4.3)	929
Hypertension	absent	1.1 (0.9-1.4)	1.3 (1.0-1.7)	32,893
	present	1.1 (0.5-2.7)	1.1 (0.5-2.7)	1,779

Except where noted, each logistic regression estimate of the relative risk was adjusted for all other risk factors in the table. The referent groups for all estimates are normal weight women within the risk factor group. 95% Confidence Intervals are in parentheses following the relative risk estimates.

[1]Adjusted for parity 0, weight gain, smoking, diabetes, and hypertension

[2]Adjusted for age 35+, weight gain, smoking, diabetes, and hypertension

women 35 years or older, primiparous women, women who smoked, and women with adequate or excessive gestational weight gain. An excess risk of perinatal mortality associated with moderate overweight was observed only for women aged less than 18 years old, primiparous women, and women with excessive weight gain.

As observed for Blacks, the stratum-specific relative risks of perinatal mortality for obesity exceeded the overall relative risk of perinatal mortality among White women who were less than 18 years old, who were 35 years or older, and who had adequate or excessive gestational weight gain (Table 6). In addition, there was a stronger association of maternal obesity with perinatal mortality among White women who had at least a high school education, had three or more previous births, did not smoke, did not have diabetes, and did not have hypertension. Moderate overweight was associated with an excess risk of perinatal mortality among women 35 years or older, women with 12 or more years of education, women with three or more previous births, and non-smoking women.

Table 6
Adjusted Logistic Regression Estimates of the Relative Risk of Perinatal Mortality for Overweight and Obesity Among Whites

Risk Group		Overweight	Obese	Number
Age	<18[1]	0.6 (0.2-1.6)	2.1 (0.7-6.2)	2,823
	18-34	1.1 (0.8-1.5)	1.5 (1.0-2.1)	24,546
	35+[2]	1.4 (0.4-4.7)	1.6 (0.5-5.7)	791
Education	<12 years	0.8 (0.5-1.2)	1.2 (0.7-1.9)	13,048
	12+ years	1.5 (1.0-2.3)	2.0 (1.3-3.3)	15,080
Parity	0	1.3 (0.8-2.0)	1.5 (0.9-2.6)	12,455
	1-2	0.8 (0.5-1.2)	1.3 (0.8-2.1)	13,642
	3+[3]	1.9 (0.8-4.7)	2.7 (1.1-6.8)	2,031
Cigarettes Smoked/Day	0	1.4 (0.9-2.2)	1.8 (1.1-2.9)	15,766
	1+	0.8 (0.5-1.2)	1.3 (0.8-2.1)	12,362
Gestational Weight Gain	inadequate	0.9 (0.6-1.5)	1.1 (0.7-1.7)	8,687
	adequate	1.2 (0.7-2.2)	2.2 (1.1-4.2)	8,623
	excessive	1.1 (0.6-1.9)	2.5 (1.3-4.6)	10,818
Diabetes	absent	1.0 (0.8-1.4)	1.6 (1.2-2.3)	27,120
	present[4]	0.9 (0.3-2.9)	0.6 (0.2-2.3)	1,072
Hypertension	absent	1.1 (0.8-1.5)	1.6 (1.1-2.2)	26,618
	present	0.7 (0.2-2.2)	0.9 (0.3-2.7)	1,510

Except where noted, each logistic regression estimate of the relative risk was adjusted for all other risk factors in the table. The referent groups for all estimates are normal weight women within the risk factor group. 95% confidence intervals are in parentheses following the relative risk estimates.

[1]Adjusted for parity 0, weight gain, smoking, diabetes, and hypertension.
[2]Adjusted for age 35+, weight gain, smoking, diabetes, and hypertension.
[3]Due to small number of deaths (n=15), these estimates are unadjusted.
[4]Due to small number of deaths (n=14), these estimates are unadjusted.

DISCUSSION

Obesity is one of the most prevalent and detrimental risk factors for chronic disease, including cancer, heart disease, hypertension, and diabetes[20-23]. The results of this study confirm that obesity is a serious risk factor for perinatal mortality as well. After adjustment for several perinatal risk factors, the overall risk of perinatal mortality for infants of obese women exceeded the risk among infants of normal weight women by 50% for Whites and by 30% for Blacks.

There was no overall risk of perinatal mortality observed among infants of moderately overweight women. Among both race groups, women less than 18 years old experienced a relative risk of perinatal mortality associated with maternal obesity which was higher than the relative risks for older women. This finding suggests that obesity present in very young women may hold more serious health consequences than obesity in older women.

Among Whites in this study, the excess risk of perinatal mortality associated with obesity was higher for several low-risk subgroups than for their high-risk counterparts (e.g. non-smokers vs. smokers, non-diabetics vs. diabetics, non-hypertensives vs. hypertensives). These results are counter to the stated findings of one earlier study[3] which concluded that there was no significant excess risk of perinatal mortality associated with obesity in pregnancies uncomplicated by other risk factors. However, a critical evaluation of that study reveals that the authors did not account for the U-shaped relationship between maternal prepregnancy BMI and perinatal death in assessing their data. Because there was an elevated perinatal mortality rate among infants of both underweight and obese women, the authors concluded that obesity per se was not an independent risk factor for perinatal death. In fact, the perinatal mortality rate ratio comparing morbid obesity to normal weight in uncomplicated pregnancies was 2.3.

Historically, many obstetricians have advocated restricted gestational weight gain or weight loss for obese women[24-28], and previous reports have suggested that the influence of gestational weight gain on infant birth weight in pregnancies complicated by obesity may be trivial[29]. However, one previous study of perinatal mortality found that the optimal weight gain for overweight women (defined as BMI >29.0) was 15 pounds at term, and weight gains higher or lower than the optimum were associated with increased risks of perinatal mortality[14]. In this study, we observed the strongest association of maternal obesity with perinatal mortality among women with excessive gestational weight gain.

However, we employed a simple categorization of gestational weight gain (inadequate, adequate, excessive) based on the 1990 recommendations of the National Academy of Sciences[19]. In addition, our estimates of total weight gain were derived either from subtracting two self-reported weights or from a weight gain item on the vital record. We could not evaluate the accuracy of our weight gain variables. Therefore, definitive conclusions about the interactive effects of maternal obesity and gestational weight gain on the risk of perinatal mortality must await the results of a well-designed prospective study with multiple measures of weight gain across the course of gestation.

Our study focused on a population of low-income women who participated in the WIC program during pregnancy. The study population included 30% of all White women and 63% of all Black women who gave birth in North Carolina during the study period (1988-90). Clearly, our study population was representative of the majority of Black pregnant women in North Carolina. However, the question of the generalizability of our findings to women with greater economic resources is important. Low-income women are more likely to experience adverse perinatal conditions that we were unable to measure in this study, including lack of social support, psychosocial stress and adverse

occupational exposures. These risk factors, if associated with prepregnancy weight, could have contributed to an association of maternal obesity with perinatal mortality which would not be observed among affluent women. Alternatively, in a middle class population we would expect the overall risk of perinatal mortality among normal weight women to be minimized, which could lead to a more pronounced effect of maternal obesity than observed in this study. Limited support for this scenario can be inferred from our finding of a stronger association between obesity and perinatal mortality among White women with 12 or more years of education compared with less educated women.

The high prevalence of obesity among young low-income women in North Carolina portends poorly not only for reproductive health outcomes but also for the long-term health and well-being of these women. This is especially true for Black women, who suffer much higher rates of mortality from obesity-related diseases than White women[17]. Unfortunately, the prevalence of obesity among low-income pregnant women in the United States has increased dramatically over the past ten years for both Blacks and Whites[30]. Despite the millions of dollars spent on various weight-loss programs every year, obesity is in most cases an irreversible condition[31]. The inefficacy of medical treatment of obesity necessitates a primary prevention approach to lowering the prevalence of obesity and its many adverse effects on health.

There are a number of competing theories about the causes of obesity. Genetic predisposition, metabolic abnormalities, and psychological disorders are all widely considered to contribute to the onset of obesity, which is usually characterized as a disease state[32-35]. An alternative perspective views the high prevalence of obesity in the United States and Western Europe not as the result of widespread individual pathologies, but rather as the evolutionary product of relatively recent and dramatic cultural, social, and economic changes[36]. This perspective suggests that primary prevention of obesity will require population-level interventions, such as changes in nutritional composition of available food supply and patterns of work-related and leisure-time physical activity.

Acknowledgements

Dr. Savitz and Dr. Hertz-Picciotto are with the Department of Epidemiology, UNC School of Public Health. This study was supported in part by the North Carolina WIC Program, and in part by cooperative agreement No. U50/CCU403457 with the Division of Nutrition, Centers for Disease Control and Prevention, Atlanta. The authors would like to thank Linda Adair, Donna Armstrong, Watson Bowes, and Steve Wing of the UNC School of Public Health for helpful comments on an earlier version of this manuscript.

REFERENCES

1. Naeye RL. Maternal body weight and pregnancy outcome. Am J Clin Nutr 1990;52:273-279.

2. Abrams B, Parker J. Overweight and pregnancy complications. Intl J Obesity 1988;12:293-303.

3. Garbaciak JA, Richter M, Miller S, Barton JJ. Maternal weight and pregnancy complications. Am J Obstet Gynecol 1985;152(2):238-245.

4. Gross T, Sokol RJ, King KC. Obesity in pregnancy: risks and outcomes. Obstet Gynecol 1980;56(4):446-450.

5. Johnson SR, Kolberg BH, Varner MW, Railsback LD. Maternal obesity and pregnancy. Surg Gynecol Obstet 1987;164:431-437.

6. Edwards LE, Dickes WF, Alton IR, Hakanson EY. Pregnancy in the massively obese: course, outcome, and obesity prognosis of the infant. Am J Obstet Gynecol 1978;131(5):479-483.

7. Wolfe HM, Gross TL, Kazzi GM. Effects of maternal malnutrition and obesity. In: Gleicher N, ed. Principles and practices of medical therapy in pregnancy. New York: Appleton & Lange, 1992:199-213.

8. Kliegman RM, Gross T. Perinatal problems of the obese mother and her infant. Obstet Gynecol 1985;66(3):299-305.

9. Calandra C, Abell DA, Beischer NA. Maternal obesity in pregnancy. Obstet Gynecol 1981;57(1):8-12.

10. Schramm WF. Obesity, leanness and pregnancy outcome. Missouri Center for Health Statistics 1981;No. 10.5.

11. Freedman MA, Wilds PL, George WM. Grotesque obesity: a serious complication of labor and delivery. South Med J 1972;65(6):732-736.

12. Peckham CH, Christianson RE. The relationship between prepregnancy weight and certain obstetric factors. Am J Obstet Gynecol 1971;111(1):1-7.

13. Tracy TA, Miller GL. Obstetrics problems of the massively obese. Obstet Gynecol 1969;33(2):204-208.

14. Naeye RL. Weight gain and the outcome of pregnancy. Am J Obstet Gynecol 1979a;135(1):3-9.

15. Lucas A, Morley R, Cole TJ, et al. Maternal fatness and viability of preterm infants. Brit Med J 1988;296:1495-1497.

16. Kleinman JC. Infant mortality among racial/ethnic minority groups, 1983-1984. MMWR 1990;39(SS-3):31-39.

17. Kumanyika S. Obesity in Black women. Epidemiol Rev 1987;9:31-50.

18. Metropolitan Life Insurance Company. New weight standards for men and women. Stat Bull Metro Life Insur Co 1959;40:1-4.

19. Institute of Medicine. Nutrition During Pregnancy. Washington DC: National Academy Press, 1990.

20. Kissebah AH, Freedman DS, Peiris AN. Health risks of obesity. Med Clin North Am 1989;73(1):111-138.

21. Van Itallie TB. Health implications of overweight and obesity in the United States. Ann Int Med 1985;103(6 pt 2):983-988.

22. Mann GV. The influence of obesity on health, part I. New Engl J Med 1974a;291(4):178-185.

23. Mann GV. The influence of obesity on health, part II. New Engl J Med 1974b;291(5):226-232.

24. Jacobson HN, Burke BS, Smith CA, Reid DE. Effect of weight reduction in obese pregnant women on pregnancy, labor, and delivery, and on the condition of the infant at birth. Am J Obstet Gynecol 1989;83(12):1609-1616.

25. Eastman NJ. Williams Obstetrics. 10th ed. New York: Appleton-Century-Crofts, 1950.

26. Eastman NJ, Hellman LM. Williams Obstetrics. 12th ed. New York: Appleton-Century-Crofts, 1961.

27. Pritchard JA, MacDonald PC. Williams Obstetrics. 15th ed. New York: Appleton-Century-Crofts, 1976.

28. Cunningham FG, MacDonald PC, Gant NF. Williams Obstetrics. 18th ed. New York: Appleton & Lange, 1989.

29. Abrams B, Laros RK. Prepregnancy weight, weight gain and birth weight. Am J Obstet Gynecol 1986;154(3):503-509.

30. Kim I, Hungerford DW, Yip R, Kuester SA, Zyrkowski C, Trowbridge FL. Pregnancy Nutrition Surveillance System - United States, 1979-1990. In: CDC Surveillance Summaries, November 27, 1992. MMWR 1992; 41(No.SS-7):25-41.

31. Schwartz H. Never Satisfied: A Cultural History of Diets, Fantasies and Fat. New York: Free Press, 1986.

32. Bouchard C. Genetic factors in obesity. Med Clin North Am 1989;73(1):67-81.

33. Stunkard AJ, Harris JR, Pedersen NL, McClearn GE. The body-mass index of twins who have been reared apart. New Engl J Med 1990;322(21):1483-1487.

34. Leibel RL, Hirsch J. Metabolic characterization of obesity. Ann Intern Med 1985;103(6 pt 2):1000-1002.

35. Bray GA. Classification and evaluation of the obesities. Med Clin North Am 1989;73(1):161-184.

36. Brown PJ, Konner M. An anthropological perspective on obesity. Ann NY Acad Sci 1987;499:29-46.

Department of Environment, Health, and Natural Resources
State Center for Health and Environmental Statistics
P. O. Box 29538
Raleigh, N.C. 27626-0538
919/733-4728

BULK RATE
U.S. Postage
PAID
Raleigh, N.C. 27626-0538
Permit No. 1862

1,100 copies of this public document were printed at a cost of $129.30 or 12¢ per copy.